# agricultural research

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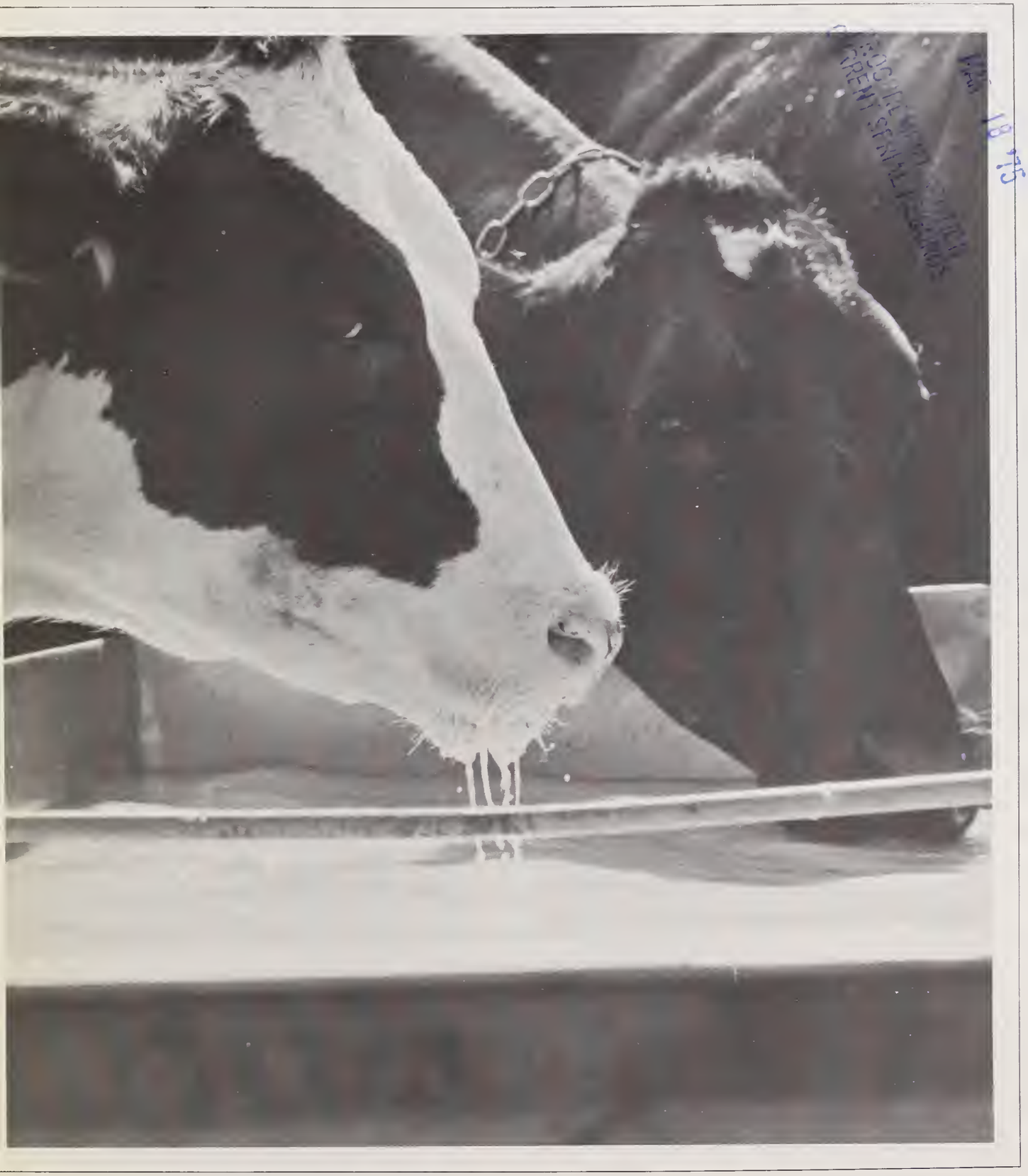

agricultural research

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## Revitalizing a Resource

Our ranges must be revitalized if we are to enjoy ample supplies of red meat. These arid and semi-arid grazing lands of the West—fit not for cropping but for growing forage—presently support about one-half the beef cattle and three-quarters of the sheep in the United States. But to produce enough meat to satisfy consumer demand, we will need even more forage. The key to gaining this required forage is range improvement. Today our ranges have often been mismanaged and overgrazed so that brush, weeds, and poisonous plants have taken over vast expanses of once productive grasslands.

To help ranchers produce more meat, ARS recently completed an intensive review of its range programs. This research is primarily conducted on 14 different ecosystems based on major types of vegetation imposed by local climate and soil. Each ecosystem—whether sagebrush or mountain meadow, shrub-steppe or prairie—is a separate realm with its own special problems. Learning how to most efficiently manage an ecosystem for forage production requires the skills of many scientific disciplines. Furthermore, the range resource must be managed with due regard for recreation, wildlife, watershed, and other multi-use values. Accordingly, the review urged intensifying multidisciplinary research and strengthening cooperative ties with range-related industries and State and Federal agencies.

In its review, the team not only assessed the efficiency of the total ARS range research effort, but also identified low-priority research that should be discontinued and high-priority research to be initiated. Among the high-priority topics are development of improved forage species, especially legumes, ways of restoring strip-mined lands, and ranch management systems for producing marketable lean meat with little or no use of concentrates.

A vast forage resource would be lost without ruminant livestock. For the grazing of beef cattle and sheep on non-tillable lands affords a noncompetitive source of high-quality protein plus minerals and vitamins for our diets. Research has brought us significant gains from our forage resource. We will gain much more as agricultural science increases the productivity of rangelands. The required research effort deserves no less than our full support in the world struggle to produce more food for more people.





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COVER: Researchers have learned that whey, once dumped into lakes and streams as a waste, can be a valuable supplement to the diets of dairy cattle. Once the cattle become accustomed to its taste, most prefer it to water (0774X1177–11). Article begins on page 8.

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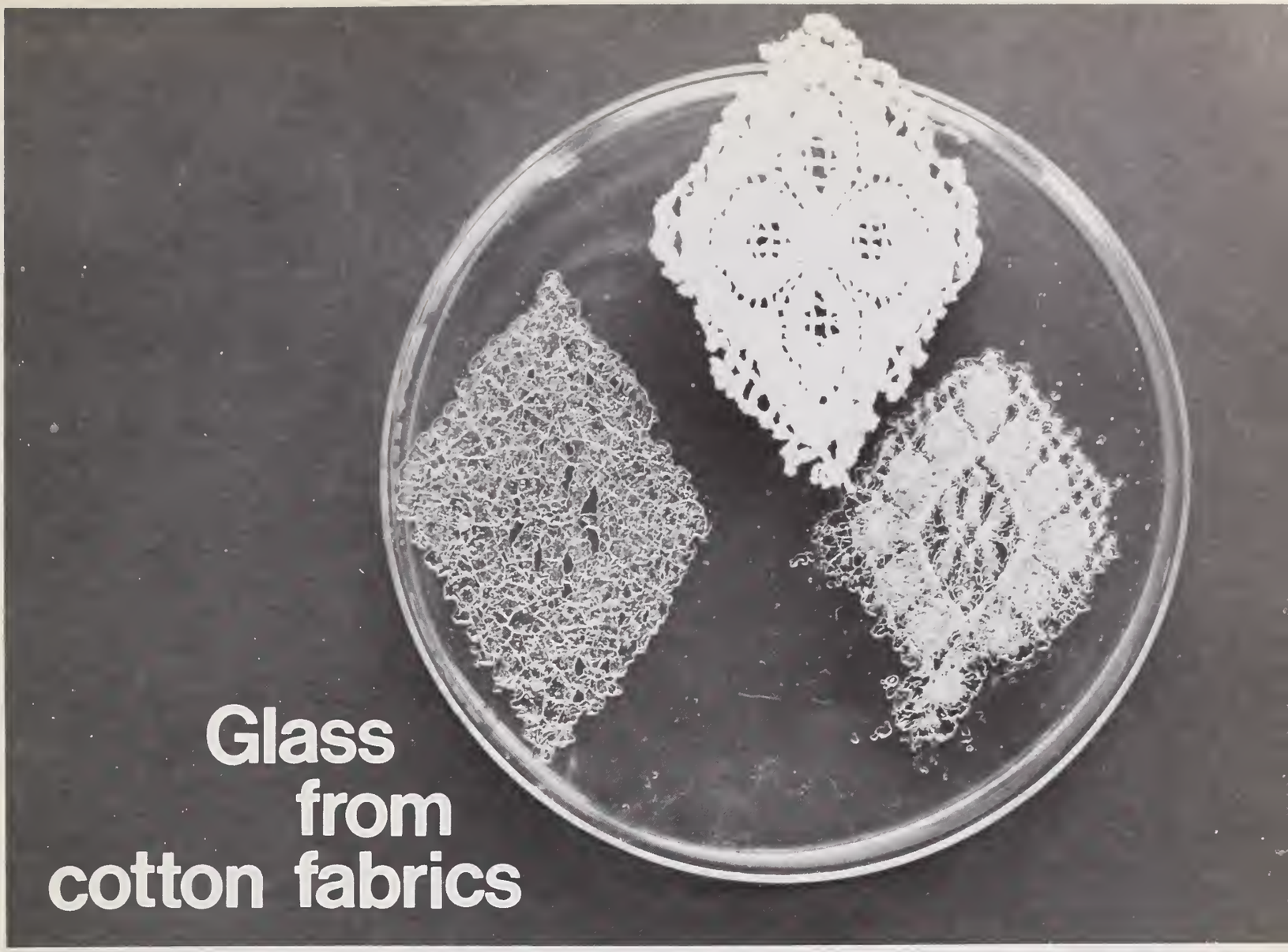


# Glass from cotton fabrics

*Conducting experiments to determine bonding qualities of solutions to cotton fabrics, scientists discovered that fabrics soaked in sodium plumbite and then heated in an oven, turned to a glasslike material. The original fabric (top) is soaked in the solution and after baking becomes glasslike (right) while retaining the original fabric pattern. If too much lead solution is added, the fabric crystallizes and breaks into small chips as on left (0874X1362–18).*

GLASS COTTON? ARS scientists have given cotton many new properties—the ability to hold a crease and resist wrinkles, repel water, resist rotting, retard fire, stretch, and even dissolve. Why not the improbable property of glassiness?

Physicist Truman L. Ward and chemist Ruth R. Benerito, working at the Southern Regional Research Center, New Orleans, have done exactly that by treating cotton fabric in such a way that it absorbs silica and becomes glassy.

Mr. Ward and Dr. Benerito are engaged in developing new chemical finishes to give cotton new and improved properties. It was during a recent series of experiments in which they were treating cotton fabric with sodium plumbite that they ran into a bit of double serendipity.

The first bit of serendipity involved treatment of the cotton fabric. The treatment consisted of soaking the fabric in an aqueous solution of sodium plumbite, washing out the excess solution, and drying the fabric. By varying the time the fabric was soaked in the solution, the scientists hoped to vary somewhat the amount of lead added to the fabric.

The scientists had been adding lead and other heavy metals to the fabric to identify specific reactive areas of the material where textile chemicals—soil retardants, flame retardants, and others—could be bonded more firmly to the cotton.

The scientists got more than they hoped for—the lead content ranged from an expected few percent of fabric weight to a quite unexpected high of 40 percent. Apparently, cotton has some natural affinity for this lead salt.

The second bit of serendipity involved the actual production of the glassy materials. While ashing the plumbite-treated cotton fabric in a porcelain crucible in a muffle furnace, hopefully for analytical purposes, the treated fabric, instead of being reduced to ashes, was changed into a glassy material.

The glasslike material was produced at a temperature of about 1100° F. when the plumbite-treated fabric was in contact with the smooth side of a high-silicon content material—such as glass or porcelain—in a low-oxygen atmosphere.

Formation of the glass seems to involve several recognizable steps. The treated fabric first turns black indicating the cellulose has turned to carbon. Further heating to about 750° F. turns the black skeleton reddish yellow then to greenish yellow, but not to the bright pure yellow of lead monoxide. Continued heating to 1100° F. produces the glassy material which bears the fabric weave pattern.

Cotton fabrics with lead contents ranging from 4 percent to 40 percent were tested and all formed glassy materials but with somewhat different properties.

When the lead content of the plumbite-treated fabric was of the order of 4 to 15 percent, the fabric changed to a translucent glassy material on the surface of the beaker, test tube, porcelain crucible, or other glass object. The material adhered firmly and retained both

***Top:*** *Mr. Ward and Dr. Benerito discuss a sample of fabric bonded to a petri dish just after it is removed from the oven (0874X1363–20A).*
***Middle:*** *Mr. Ward holds one of the best examples of lace transfer to date. The delicate pattern was bonded to the rounded flask when the sodium-plumbite-soaked cotton was baked in an oven (0874X1362–28).*
***Right:*** *One of the potentially useful characteristics of the new glasslike material is that it can bond together glasses of unlike composition. Here, Dr. Benerito holds a beaker bonded to a saucer. The bond between the two glasses is so strong that upon impact the different glasses will break, but the bond will remain intact (0874X1361–14).*

the shape and fiber pattern of the cotton fabric from which it was made. It could be written on with an ordinary lead pencil and erased easily.

When the lead content of the treated fabric was of the order of 20 percent or higher, the glassy material separated in flakes from the silicon surface on which it was made. Examination of the flakes revealed the fabric weave was still present. Moreover, the flakes were hard enough to scratch soft glass and stainless steel and they did not melt in a bunsen burner flame at temperatures approaching 2700° F.

The glassy materials made from low lead content cotton have the unique property of easily and firmly bonding together glasses of different composition that are usually very difficult to join. In their experiments with the new material, Mr. Ward and Dr. Benerito very readily joined together such glasses as Pyrex, Vycor, porcelain, and soft glasses in various combinations.

After cooling, the bonds are so strong that under applied force the joined glasses ruptured while the bond remained intact. This should be of real interest to scientific glassblowers who cannot now knit some dissimilar glasses needed for specialized laboratory work.

The glassy products can also be made to change color by exposing them to the direct heat of an open gas flame. The original clear color can be changed to gold, deep purple, silver, or gray by varying the time the glass is exposed to the open flame.

Interestingly, the color acts as a one-way mirror similar to the half-silvered mirrors produced commercially. And by reheating the colored glass in the muffle furnace at 1100° F. the glass can be returned to its original clear, colorless state. The color reversal process can be repeated.

The glassy materials are acid and alakli resistant. In addition to application in scientific glassware, they may find application in radiation shields, variable conductors, labels, mirrors, and other consumer products. □

# Protecting cured meats

THERE may be a relatively simple way of controlling the formation of nitrosamines in cured meat products like frankfurters and bacon.

The way may be to *require* a compound to be used in the curing process that up until now has only been *permitted* in limited quantities to aid in developing color.

The compound is sodium ascorbate—or its close relative, sodium erythorbate. Sodium ascorbate is the sodium salt of vitamin C. Its use in the processing of cured meats is presently restricted, not because of any question of its safety, but because its only recognized contribution has been to the appearance of the products.

Now there is some evidence that sodium ascorbate or erythorbate may control the formation of nitrosamines. The concern about nitrosamines arises from the fact that they produce tumors in test animals. Thus they may be carcinogenic to man, although this has never been proved.

Some cured meats are a potential source of nitrosamines. This is because meats are cured with sodium nitrite (or with sodium nitrate which is converted to sodium nitrite). Sodium nitrite can combine with certain amines which occur naturally in minute concentrations in meat, to form nitrosamines.

Almost 3 years ago, ARS chemists Aaron E. Wasserman and Walter Fiddler and their research colleagues at the Eastern Regional Research Center in Philadelphia discovered a nitrosamine known as N-nitrosodimethylamine (DMNA) in a few samples of frankfurters. The most they found in any one sample was 84 parts per billion (ppb). To detect such infinitesimal quantities they had to use a highly sophisticated gas chromatographic technique with an alkali-flame ionization detector. They confirmed their results with a mass spectrometer to be sure that the traces they found were indeed DMNA.

Later, using these same techniques, they confirmed reports that trace amounts of another nitrosamine, nitrosopyrrolidine (NOPyr) appear in fried bacon. Subsequent testing has shown that while raw bacon is characteristically free of nitrosamines, NOPyr commonly develops during frying. The rendered fat contains more NOPyr than the edible portion.

In the course of their study of this reaction, Dr. Wasserman and Dr. Fiddler noted that using sodium ascorbate or sodium erythorbate along with nitrite greatly suppressed DMNA formation in frankfurters in laboratory studies. With the usual 2-hour cure, no DMNA was found if the maximum allowable amount (550 parts per million—ppm) of one of the compounds was used. Ten times this amount (5,550 ppm) controlled DMNA formation even with a 4-hour cure.

These encouraging results prompted large-scale processing tests of bacon by the meat industry, in cooperation with ARS and the U.S. Food and Drug Administration. The difficulties of conducting such large-scale tests, where the methods of analysis are so exacting and time consuming, are enormous. Though the tests have been in progress for some time, they have not yet yielded conclusive results.

If the tests bear out the preliminary indications, it may be that the maximum amounts of these vitamin C compounds now allowed in the curing of meat products will be replaced with minimum requirements for their use. This, along with reduced amounts of sodium nitrite, may guard against the possible dangers of nitrosamines in these foods. □

*Dr. Holbrook sprays a potato test plot at the Aroostock State Experimental Farm with the water suspension of the resting spores in biological efforts to fight aphids. On test plots the spores initiated infection and dead aphids began appearing 2 days after application (BN–42155).*

# Zapping life from aphids

BIOLOGICAL CONTROL of aphids on potatoes—and possibly on many other crops—is moving closer to practical application. A team of State and Federal scientists is overcoming some major hurdles that have held back serious efforts to employ one of nature's own systems of checks and balances.

In nature, insects are susceptible to more than 100 known *Entomophthora* fungus diseases. The fungus spores germinate like seeds and produce threadlike stalks that spread through the insects' bodies, first weakening, then destroying the pests. At times, these disease agents destroy vast numbers of insects. Their effects in nature are sporadic, however, and too little has been known about them to exploit these fungi as added weapons in man's war on insect pests.

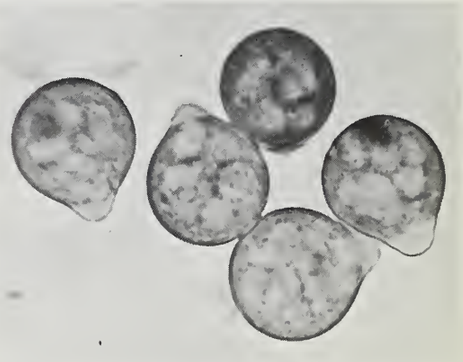
No adverse effects of insect-attacking fungi have been observed on potatoes or other plants. Mice, when exposed to fungi in laboratory experiments, showed no adverse effects. Workers handling *Entomophthora* during the past 2 years of research have reported no allergies or other adverse effects on their health as a result of exposure to the fungi. Honey bees and other beneficial insects also appear to be unharmed by *Entomophthora.*

Entomologists Richard S. Soper, Maine Agricultural Experiment Station, and Frederick R. Holbrook, of the New England Plant, Soil and Water Laboratory, both located at Orono, obtained promising results in controlling aphids during 3 years of laboratory and field plot experiments with *Entomophthora* fungi. Field tests were made in Maine and in Florida in cooperation with Robert A. Conover, director of the Florida Agricultural Experiment Station, Homestead. Additional tests were conducted at Presque Isle, Maine, last summer, in cooperation with Frederick E. Hutchinson, director of the Maine Agricultural Experiment Station.

In the past, sufficient quantities of *Entomophthora* could not be produced in the laboratory for extensive testing. Dr. Soper and Dr. Holbrook devised an unusual rearing medium containing egg yolk, among other constituents, and now are able to produce about 1 kilogram (2.2 pounds) of spores weekly.

The spores are held in a dormant state in a refrigerator until needed for laboratory tests or until seasonal conditions are appropriate for field experiments. Breaking the spores' dormancy has been a problem that the scientists

*The primary conidia—asexual spores—of the fungus* Entomophthora thaxteriana *are shown here (1000×) in the stage which is responsible for the rapid buildup of infection in the aphid populations (BN–42157).*



overcame by special handling techniques. Heretofore, dormancy and insufficient moisture caused slow germination of the spores and inadequate control of aphids.

Early in the day of application, the entomologists combine the spores with water in a blender and hold the mixture in a mechanical agitator for 12 hours. These conditions break dormancy, resulting in better than 80 percent germination—a rate considerably higher than has been achieved by other methods.

Early in the evening of the same day, the spore mixture is applied on the crop with a conventional tractor-mounted sprayer. The moist night air and dew on the foliage provide a suitable microclimate for the fungi. On experimental plots dead aphids began appearing 2 days after application.

Dr. Soper and Dr. Holbrook are interested in using *Entomophthora* against green peach aphids primarily to control potato leaf roll virus, which is spread by the aphids. The disease reduces crop yields and renders seed potato crops useless for seed. *Entomophthora's* quick action against green peach aphids kills them before they develop wings and fly to other, uninfected fields. The fungus also works fast enough to protect crops in areas where the aphids are numerous enough to cause direct feeding damage to potatoes.

Because fungicides used to control potato diseases could interfere with use of *Entomophthora* fungi to control aphids, the scientists screened commercially available fungicides and found two that do not kill *Entomophthora*. Additional compatible fungicides may be tested after further screening.

Usually, a biological control agent or chemical that is specific for one pest species is not economically advantageous because of high production costs for a limited application of the material. Aphids are virtually universal pests, however, infesting many crops and ornamental plants. The potential benefits of *Entomophthora* may have even greater implications than for potato crops alone. □

# FEEDLOT WASTES CONTROL EROSION

One potential source of pollution can be turned against another and soil fertility can be increased by using cattle feedlot waste to control wind erosion on cropland.

Field plot studies at Manhattan, Kans., show that animal waste—which can be a water pollutant in the feedlot—is about as effective as anchored straw in restricting soil loss from highly erosive sandy soil.

Wind erosion damages land and crops and the blowing dust is a source of air pollution.

At least 30 tons (wet basis) of animal waste per acre tandem-disked into the soil or 15 tons per acre spread on the soil surface reduced soil loss from about 4 tons per acre to less than a half ton. The 88 percent reduction in soil loss, in comparison with that on unprotected plots, was on soil averaging 74 percent sand, 20 percent silt, and 6 percent clay.

ARS agricultural engineers Neil P. Woodruff and Jerry D. Dickerson and soil scientists Leon Lyles and Dean V. Armbrust found that straw anchored with a straight-disk packer, a recommended wind erosion control practice, reduced soil loss by 92 percent when a half ton per acre was applied.

In cooperation with the Kansas Agricultural Experiment Station, Manhattan, the researchers measured soil loss on the second day after application. They employed a portable wind tunnel operating at a windspeed of 36 miles per hour to simulate wind erosion.

A second measurement in May, about 8 months after application, evaluated erosion control after the animal waste and straw had weathered over winter. At least 15 tons of animal waste per acre, surface applied, or a half ton of anchored straw then reduced soil loss by 90 percent. Sixty tons of tilled-in animal waste was needed for equal protection.

More than double the usual overwinter precipitation at the test site caused soil crusting and extremely low susceptibility to wind erosion in May. Overwinter weathering loss, determined by comparing air-dried weights of animal waste in September and May, averaged 50 percent for surface applied and 40 percent for tilled-in manure. Thus, nearly twice the amount of manure would need to be applied in the fall to obtain equal protection the following spring. However, those weathering losses were possibly double what might be expected with normal precipitation, the researchers said.

They see several advantages to tilling-in animal waste to restrict wind erosion. The likelihood of surface runoff carrying high concentrations of pollutants is minimized by incorporating waste into the soil.

More of the fertilizer value of the waste is retained because less of the nitrogen is lost into the air by volatilization. And tilling-in provides an outlet for disposal of at least twice as much animal waste as surface application.

The amount of feedlot waste required for effective wind erosion control depends on soil texture and roughness as well as the application method. Based on the results of their experiment, the scientists prepared reference graphs for use by USDA's Soil Conservation Service in determining the amount of feedlot waste needed to restrict wind erosion in various field situations. □

*Private dairymen and milk producers are cooperating with ARS researchers in field studies using whey as feed for dairy herds. Here, Holstein cows and heifers on Edwin Gossner's Alagma Farm in Smithfield, Utah, drink whey that is a byproduct of Gossner's Cheese Factory (0774X1176–41).*

# DAIRY CATTLE TAKE TO LI

*Cutting of the curdled milk allows separation of the curd and whey. The curd then settles to the bottom of this 30,000-pound tank. About 3,000 pounds will become cheese; the remaining 27,000 pounds will become feed for cattle (0774X1177–31).*

LITTLE MS. MUFFET, famed femme of the nursery rhyme, had the right idea when she washed down her curds with whey. An ARS study shows that liquid whey, a cheese processing waste, is a source of valuable nutrients for cows that has long gone unnoticed by dairy farmers.

Throughout centuries of cheesemaking, whey has, for the most part, been discarded. ARS researchers at Utah State University, Logan, taught dairy animals to consume whey in lieu of other feeds. Subsequent field tests showed 100 pounds of whey to be equal in nutrition to 7 pounds of corn or barley.

This finding arrives at a critical time for many small cheese processing plants. Large cheese plants install and operate expensive whey drying equipment. Small plants, unable to afford the equipment and having no other liquid whey outlets, dump their wastes into sewers and streams. When pending environmental regulations prohibit further whey pollution, many small plants will be in trouble and may have to shut down.

*Feeding whey to cattle will find favor among environmentalists as well as with dairymen. Here, the Bear River now runs clear in front of the Cache Valley Dairy. Before, whey could be and was dumped into the river (0774X1177–19).*

# UID WHEY

Such a situation could spell dairy product shortages and higher consumer prices. To avert this, ARS animal scientists Melvin J. Anderson and Robert C. Lamb, Logan, sought alternative means of disposing of the liquid whey.

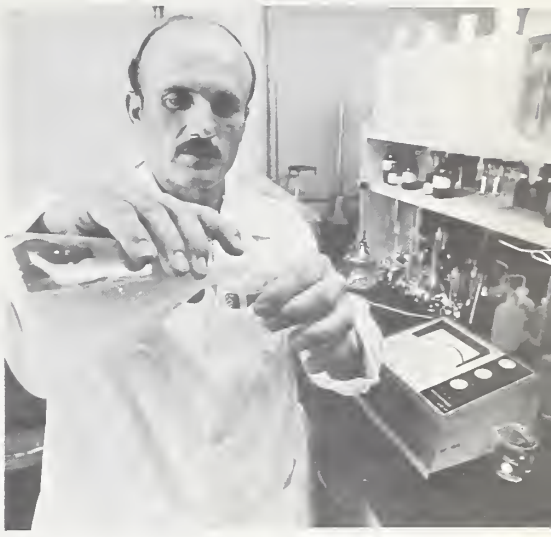
In one study, 16 Holstein cows were fed fresh whey in various combinations with water, hay, and grain. Whey replaced as much as 13 pounds of hay per cow daily. Animals consuming high whey levels tended to gain more weight than animals consuming low levels, but there was no apparent effect on milk production or on milk fat, protein, or solids-not-fat content. Regardless of the whey and water combination used, all cows tested drank approximately 25 gallons of liquid per day.

In a second study, ARS researchers compared weight gains in 5- to 7-month-old heifers consuming combinations of whey and grain. Heifers given whey and no grain showed a growth rate equal to heifers fed 5 pounds of grain and no whey daily. Animals who washed down their grain with whey showed the best growth rate of all.

To get animals to drink whey, they must first be restricted from water for 8 to 12 hours per day. Once the dairy animals become accustomed to the whey, water restriction becomes unnecessary. Given a choice between water and whey, most animals preferred whey.

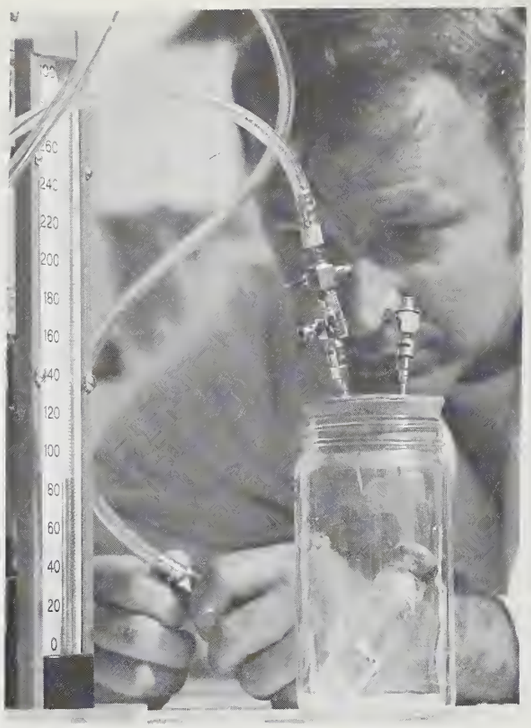
If dairy farmers can obtain the liquid whey at a cost less than 15 cents per 100 pounds of whey, it will be profitable for them to feed their stock whey in place of some barley. Since the liquid whey's disposal is a problem to the cheese plant, the waste should be available almost free for the taking. It is estimated that farmers living within 25 miles of a plant would find liquid whey an economic feed source at present feed grain prices.

Farmers are cautioned that flies are attracted to the whey and can present problems unless spilling is avoided and the whey is consumed within a short time. Animals readily consume 1-day-old liquid whey, but anything older becomes too acidic. Although most cheese plants pasteurize their milk, if animals receive whey from unpasteurized milk that originated in a diseased herd, the disease could spread. Care and proper management, however, should make liquid whey feeding to dairy animals a boon to farmers, producers, and consumers alike. □



**Above:** *It has been noted by ARS researchers that while cattle will readily consume fresh and 1-day-old whey, they will not drink older whey due to increasing acidity. Graduate student Richard Wiscombe determines the pH factor of whey just delivered to the lab. The usual reading for fresh whey is slightly acidic, 6.1 (0774X1180–8A).*

**Below:** *Dr. Anderson scans the feeding schedules of his Holstein cows in the experimental station at the Utah State University Dairy Farm. Dr. Anderson checks the schedule to compare feed consumption against milk production and body weight (0774X1179–4A).*



***Right:** Research technician Herbert M. Cook secures the newly developed telemetering capsule to a stomach tube for insertion into the cow's rumen through the esophagus (0874X1248–9A).*
***Above:** The metering unit, in its mineral oil environment, cannot be calibrated after it is in place in the rumen. Mr. Cook calibrates the pressure telemetering capsule using a mercury manometer (0874X1250–10).*

# Improved rumen monitor

A newly developed pressure transmitter is small and inexpensive enough that it can easily be placed in a cow's rumen to monitor its activity and need not be recovered.

Studies of pressure variations produced by contractions and movements of the rumen may lead to a better understanding of rumen function in normal and diseased animals. They may also lead to ways of improving the cow's conversion of forage to energy.

Electronic engineer Joseph L. Riley, National Animal Disease Center, Ames, Iowa, first developed a radio-telemetry device, a capsule transmitter that could be swallowed by a calf (AGR. RES., Feb. 1972, p. 6). That method, however, required surgery in order to remove the expensive capsule from the rumen.

Mr. Riley and technician Herbert M. Cook have now developed an inexpensive capsule small enough to fit into a stomach tube for insertion into the rumen through the esophagus. "Major surgery does not have to be performed on the animal to obtain recordings of rumen activity, and the records are not influenced by surgery," Mr. Riley said.

Development of the new capsule was made possible by the design of an inexpensive variable capacitor transducer—the expensive part of the first transmitter.

Researchers solved the problem of the hostile environment of the rumen by packaging the unit inside a plastic bag filled with mineral oil. The oil protected the instrument from the rumen contents but allowed pressures to be transmitted to the transducer and radio waves to be emitted.

The transmitter could not be calibrated after being placed in the rumen; however, the change in sensitivity over a 3-day-test period was not great. "This capsule offers a major advantage when doing an experiment where one wishes to monitor rumen motility for 2 or 3 days and recalibration is not important," Mr. Riley said.

Before the development of radio-telemetry devices for monitoring rumen movements, surgery was required to prepare the animal, and it had to be restrained because of tubes or wires connecting it to equipment. With early radio-telemetry devices, surgery was necessary to place the transmitter in the rumen and recover it. □

# Detecting apple bruises

MEASUREMENT of near-infrared reflectance shows promise as an automated, objective way to detect bruises in apples graded for the fresh market.

About an eighth of all handpicked Michigan apples now have bruises classed as grade defects under official USDA grade standards, and the amount of bruising may increase with use of less-skilled hand pickers or mechanical harvesting methods. The grading of apples for bruises and other surface defects is presently conducted a hand operation subject to human error.

ARS and Michigan State University engineers at East Lansing found that average near-infrared reflectance is less for bruised than for unbruised apples at all wavelengths between 700 and 2,200 nanometers. They suggest that reflectance measurement of bruising might be added to presently used automatic systems for color grading of apples.

In their study, ARS agricultural engineer Galen K. Brown and agricultural engineer Larry J. Segerlind, and metallurgical engineer Robert Summitt, both of Michigan State, found that reflectance is lowered immediately upon bruising and continues to decrease with time. Reflectance of unbruised apples also decreases slightly as storage time increases.

The engineers believe the difference in reflectance is caused by a combination of cell destruction in the bruise, an altered water-air relationship in tissue, and a gradual chemical change in cell material.

The engineers produced uniform bruises in Jonathan, McIntosh, and Golden Delicious apples by dropping a 263-gram (9.2 ounce) flat steel plate on the fruit from a height of 15 inches. They made reflectance measurements within 2 hours after bruising as well as after 1, 7, and 28 days in cold storage.

The engineers identified two potential ways of detecting bruising: the difference in reflectance of unbruised and bruised apples for wavelengths of about 800, 1,200, and 1,700 nanometers, and the reflectance of unbruised apples divided by the reflectance of bruised apples at some wavelength between 1,400 and 2,000 nanometers. □

# Goodbye 'little green apples'

IF "God didn't make little green apples" as the song says, excessive nitrogen fertizer did. That's what scientists have found in studies near Cashmere, Washington.

ARS plant physiologist Max Williams and technician Harlin D. Billingsley, seeking a way to obtain a more uniform light yellow color in Golden Delicious apples, discovered that high amounts of nitrogen fertilizer cause an excess of chlorophyll in the apples. Also, the heavy foliage growth shades the apples in the lower zones of the tree and prevents proper coloring and maturing.

The green color and the mixture of green and yellow colored apples detracts from customer appeal. It also causes other problems. Green fruit is lower in quality, losing its firmness in storage faster than the light yellow apples.

Leaf color, the researchers found, provides a clue to the nitrogen fertilizer level. Dark green leaves are associated with too much nitrogen. Light green leaves are associated with a more desirable nitrogen level. Nearly 90 percent of the apples produced by trees with light green leaves are yellow in color.

Based on data collected in the experiments, the scientists are developing a leaf-color guide which will help growers determine proper fertilizer rates for their trees. Proper fertilization will help save time and money and enhance the quality of fruit offered to the consumer at the marketplace.

Three levels of nitrogen treatment were tested. Each test included randomly-selected trees, all 10 years old, grown in a deep sandy silt-loam soil, free of arsenic.

Treatments tested included: (1) no or low nitrogen levels, (2) a moderate level, 340 grams (0.75 lb.) of nitrogen per tree, and (3) a high level, 680 grams (1.5 lb.) of nitrogen per tree. Nitrogen was applied in the fall as ammonium nitrate, and all trees were thinned chemically and by hand within 35 days after full bloom. The researchers then recorded yields, fruit size, fruit color, trunk circumference, leaf color, and leaf nitrogen levels annually for all the experimental apple trees.

By the fourth year of the study, measurable differences in fruit color between the three treatments appeared. Examining the data revealed a close correlation between leaf-nitrogen and fruit color.

During the study, leaf-nitrogen levels ranged from 1.8 percent of the dry leaf weight for the low fertilizer treatment to 2.6 percent for the high fertilizer treatment.

When leaf nitrogen fell between 1.8 to 2.1 percent, as occurred with the low or no nitrogen fertilizer treatment, nearly 90 percent of the apples were yellow in color.

As leaf-nitrogen increased, vegetative growth increased, fruit grew greener, and quality decreased. Some limbs produced yellow fruit, but the majority produced various shades of green.

High nitrogen application increased tree growth and fruit yield, but the small increases in yield did not offset the potential losses due to the greater number of green apples. □

# Compromise reduces foot rot and erosion

PLANTING wheat varieties that are resistant to *Cercosporella* foot rot and also employing benomyl, a chemical that controls the disease, increases erosion control and limits foot rot casualties to economically acceptable levels.

Pacific Northwest wheat farmers, particularly those in the abundant wheat lands of eastern Washington face a "damned if you do, damned if you don't," problem. Many wheatlands are subject to severe wind or water erosion. Seeding winter wheats early reduces erosion by providing leaves and roots to protect and hold the soil. The earlier that winter wheat is seeded, however, the more susceptible it is to *Cercosporella* foot rot, a soilborne disease that can reduce grain yields as much as 75 percent.

ARS agronomist Clarence J. Peterson, Jr., and Washington State University plant pathologists G. W. Bruehl and Rollin Machtmes, Pullman, sought a happy medium that maximized erosion control while minimizing disease losses.

The researchers studied four locally developed semidwarf wheats over two growing seasons. Each wheat variety differed in foot rot resistance. The studied wheats included: C.I. 13438 (susceptible); Nugaines (slightly resistant); Lake (moderately resistant); and Cerco (resistant).

During the first growing season, the researchers seeded wheats on Sept. 9, 16, and 23. The following spring they applied benomyl—used experimentally since it is not registered for use on wheat—at rates of 0, 1/8, 1/4, 1/2 and 1 pound per acre.

In the second season, the researchers seeded the wheat on Sept. 8, 15, 23, and Oct. 2, and applied benomyl at rates of 0, 1/8, 1/4, and 2 pounds per acre.

Not surprisingly, the tests showed that early seeding favored foot rot. Susceptible wheats, however, responded to benomyl well enough to produce economically acceptable yields. The more foot rot resistance a wheat variety possessed, the less benomyl it needed to be profitable.

Cerco needed no benomyl to give good yields but other problems, such as susceptibility to powdery mildew, poor flour quality, and inadequate winter hardiness kept it from being the "ideal" wheat.

In conjunction with the benomyl, Nugaines yielded highest from the earliest seeding, while both Luke and Cerco performed best from mid-September seedings. When protected by benomyl, C.I. 13438 yielded well from all seeding dates.

Cerco's bred-in resistance proved more effective in controlling foot rot disease than did benomyl. Therefore, future research will emphasize developing a high yielding, disease-resistant wheat that can be seeded early.

In the meantime, using benomyl in conjunction with wheat varieties possessing at least some resistance, and seeding in September offers a workable compromise between erosion and foot rot disease control problems if and when benomyl is registered for use on wheat. □

*The rolling hills of the State of Washington produced over 100 million bushels of winter wheat during 1974 to rank second in the Nation. Researchers are continuing the quest for a compromise solution to the problems of erosion control and* Cercosporella *foot rot, a disease that can reduce grain yields as much as 75 percent (BN–42156).*

# Beef cows in confinement

How do those highly prized marbled sirloins and juicy rump roasts get that way? The major reason lies in careful husbandry.

Research over 10 years has shown that Angus, Brahman, and Brahman × Angus crossbred cows and their calves observed in confinement or in dry lot in various nutritional studies have higher level of condition—they weigh more—than cows which graze in pasture land.

To obtain reproductive performance, nutritional requirements were established at the Iberia Livestock Station in Louisiana, in cooperation with the Louisiana State Agricultural Experiment Stations at Jeanerette and Crowley. Dry cows were fed 9 pounds of total digestible nutrients (TDN), which is the amount of feed actually digested, to 16 pounds for cows with calves. Cows to be bred in a breeding season lasting less than 75 days required somewhat higher level post-calving nutrition.

In cows confined up to 8 years, pregnancy rates for the last several years were an impressive 100 percent in 75-day breeding periods. Feeds were not the most expensive. The ration consisted of whole or ground shelled corn, hay, cottonseed meal, bone meal, mineralized salt, and 21,000 units of vitamin A daily. At all times the cows were provided with a "bovine snack bar"—clean water, salt, and bone meal.

Researchers also reported that more economical feeds such as green chop (feed fresh from the field) and silages could be successfully used to provide most of the TDN as well as the total protein required for dry and lactating cows.

Another advantage of confinement was the more efficient use of land afforded by a small area. Unlike the traditional system of grazing the forage continuously, harvesting and bringing the feed to the cows resulted in higher yields of forage feeds per acre.

Areas of confinement were part concrete—particularly in the feeding area—to provide adequate drainage from high rainfall. The location of the concrete part of the dry lot was accessible for easy manure removal. Part of the lot was dirt, with a shed area giving protection from summer sun and winter rains. In contrast to cows on surrounding pastures, few cases of intestinal disorders or anaplasmosis were observed in confined cows. They did not require worming for parasites. Counts for egg larvae in manure were very low.

Calves born in unsanitary areas of confinement were more prone to pneumonia, scours, and hair balls than those kept on pasture, but the incidence of scours was reduced when calves were put on pasture for several hours a day.

Researchers found that calves 75 days old also needed access to feed in the trough with their dams or to creep food, smaller troughs unavailable to the dams. Locating the creep away from muddy areas greatly influenced weight gain.

Both cows and calves in dry lot gained more weight than cows on pasture, probably, researchers concluded, because of their more uniform feed supply. Also, contrary to popular belief, it was never necessary to trim the feet of confined cows.

"The effects of confinement on production fall largely in the plus column," said ARS animal physiologist Walter L. Reynolds. "Even though calves need more attention, confinement affords the livestock producer the precaution of close observation." □

# Measuring red blood fragility

A RAPID NEW PROCEDURE for measuring red blood cell fragility has been developed by an ARS biological laboratory technician.

The procedure, which requires only tiny amounts of whole blood and is about four times faster than the old method, is a necessary diagnostic tool in such blood disorders as anemias, metabolic dysfunctions, and the effects of many drugs and chemicals on the red cell membrane.

Developed by Ellen G. Steel at the Veterinary Toxicology and Entomology Research Laboratory, College Station, Tex., the new procedure will be particularly useful in pediatrics and in small laboratory animals because of the very small amounts of whole blood required for diagnosis.

Mrs. Steel, who is also a registered medical technologist, said that enough blood for testing could be obtained from a pin prick, thus eliminating the need for using a needle and syringe and the accompanying psychological trauma to children during treatment.

The new procedure would be beneficial in checking small laboratory animals because of the animals' small total blood volume. This is important if the blood cell condition must be checked several times during a short period.

Equally important, Mrs. Steel said, is the simplicity in technical operation and the accuracy attained, both with currently available laboratory equipment. The new method takes slightly more than half an hour while the old procedure required 2 hours.

Both the old and the new methods for testing red cell fragility involve placing the red cells in solutions containing different amounts of sodium chloride to determine the degree to which cell membranes become permeable and lose hemoglobin to the salt solution, a phenomenon known as hemolysis.

Normal cells placed in 0.85 percent salt solution will not change size for several hours. As the salt concentration is reduced, the osmotic forces cause swelling of the cell until the cell membrane becomes permeable to hemoglobin, and increasing amounts of it cross the membrane and are lost to the salt solution.

In measuring cell fragility with the new method, 0.20 milliliters (ml) of different salt concentrations are dropped into each of 12 tiny wells on a plastic titration plate followed by 0.025 ml of diluted whole blood in each of the wells. The plates are covered and incubated for 30 minutes at room temperature, given a brief centrifugation, and then examined for the points where hemolysis begins and where it is complete. These points indicate to the veterinarian or physician the degree of cell damage and thus the extent of anemia, dysfunction, or poisoning. □

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# New liver biopsy technique

SURGICAL PROCEDURES have been developed by veterinarians for the removal of large—25 to 100 gram—liver samples from live animals.

Normally, the removal of large liver samples has been kept to a minimum because of high mortality rates. Bleeding from the liver is very difficult to stop because of the large number of blood vessels and the extremely soft character of the tissue. Consequently, liver samples for residue studies were usually limited to tiny amounts removed with a hollow needle. Now, samples of 25 to 100 grams can be removed by veterinarians with relative safety.

In their residue studies at the Veterinary Toxicology and Entomology Research Laboratory, College Station, Tex., ARS veterinarians Donald A. Witzel, James H. Johnson, and Royce L. Younger have been taking large liver samples, frequently on a repeat basis, with very good results.

To control the otherwise inevitable hemorrhage of the cut surface of the liver, the veterinarians decided to try placing a row of vertical mattress sutures along the incision line before the liver was incised.

In placing the sutures, however, they departed from standard practice and increased the surface area of the suture material. Small pieces of plastic tubing were threaded onto the sutures during stitching so that the pieces of tubing were on both the upper and lower surfaces of the liver to act as compression pads. The sutures could then be drawn tighter than normal to produce the necessary pressures to stop bleeding.

In the past, only light tension could be applied to sutures in the liver capsule and even when such suturing was successful, the surgeon had to wait for an extended period of time before completing the operation to make certain that bleeding had been stopped on the entire cut surface. With the new procedure the surgeon can be immediately satisfied that bleeding has stopped and complete the operation rapidly.

When examined 6 months later, all of the livers on which the new procedure was used had healed completely. Moreover, there was no indication that tissues had been affected adversely by the presence of the inert plastic tubing.

The procedure may also find application in human medicine. For example, it could possibly be used to stop bleeding in persons whose livers may be damaged in automobile or other types of serious accidents. □

## Boll weevil sterility

A simple behavioral test has helped to determine quickly and accurately the degree of sterility in laboratory-reared male boll weevils, *Anthonomus grandis* Boheman.

Locomotion as a measure of vigor can predict the efficiency of the chemosterilant busulfan. The more physically active the weevils are, the less sterile they are judged to be.

Ordinarily, the degree of sterility in weevils to be released in control programs is determined by procedures which may take 3 weeks to complete—hatchability of eggs, emergence of adults from busulfan-treated parents, and visual observation of testicular damage.

Researchers fed 100 male weevils 0.09 percent busulfan for 6 days. The locomotor test then consisted of 10 trials in which 10 boll weevils at a time were allowed to crawl at random from a circle 5 centimeters in diameter drawn in the center of a piece of plastic-covered carboard. The score was computed as a percentage of the 100 weevils that crawled outside the circle during the 10 test periods, lasting 1 minute each.

If the weevils were too active they were judged to have consumed an inadequate amount of busulfan and were fed for an extra day.

Scores from the tests were correlated with the sterility determined by testicular examination of weevils from the same population 21 days after they were removed from the chemosterilant-treated diet.

The locomotor test developed by ARS research entomologists Glenn Wiygul and Jack W. Haynes at the Boll Weevil Research Laboratory, Mississippi State, Miss., was used successfully during the 1973 phase of the Pilot Boll Weevil Eradication Experiment.

## Test for frozen meat

DETECTING MEAT that has been frozen and then thawed has been made easier because of a new testing procedure.

ARS food technologist Kenneth E. Beery, Western Regional Research Center, Berkeley, Calif., said the test measures the ratio of enzyme release. When crushed under pressure, a 1-inch-cube of fresh meat releases about a 9 to 1 ratio of sarcoplasmic to mitochondrial enzymes in the juice. Meat that has been frozen and then thawed gives about a 1 to 1 ratio.

"Although the enzyme release is a direct indication of whether meat is fresh or thawed, it doesn't affect meat quality in any way. If meat is frozen and thawed properly, there is little difference in quality, texture, or color," Dr. Beery said.

Dr. Beery conducted the research with funds supplied by the U.S. Army's Natick Laboratory near Boston, Mass. The test will be used on meats purchased by the Federal Government, when specifications require fresh meat.

## Extracting oat protein

OAT PROTEIN, nutritionally one of the best of all cereal proteins in its amino acid balance, may become increasingly useful as a food additive with the advent of procedures for extracting it from hulled oats.

One method for obtaining oat protein concentrate was devised in laboratory studies by ARS chemist Vernon L. Youngs, National Oat Quality Laboratory, in cooperation with the Wisconsin Agricultural Experiment Station, Madison.

The hulled oat kernels, groats, are milled into flour and bran. Each mill stream is slurried individually with water and then centrifuged, producing a layer which contains 50 to 60 percent protein, in each slurry. Two other layers obtained through the centrifugations should also be commercially important, Dr. Youngs said. A bran layer, containing more than 16 percent protein is produced from the bran slurry, and a fairly pure starch fraction is extracted from the flour slurry.

Oat starch granules are smaller than starch particles from all other cereal grains except rice.

Protein can also be extracted from oats by employing a new technique developed at the Northern Regional Research Laboratory, Peoria, Ill. Researchers there used dilute alkali solution to dissolve protein from ground oats for separation by sieving, centrifuging, and precipitation (AGR. RES., Oct. 1973, p. 13).

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## Improved apple displays

A NEW METHOD of displaying Golden Delicious apples in retail food stores should put smiles on consumer faces and not cause grocers to shed any tears either.

ARS studies show that displaying Golden Delicious apples in 8-pound tray-packs covered with shrinkg film bags increases sales, reduces labor costs, and eliminates a nagging disposal problem for grocers.

Currently, Golden Delicious apples are delivered to the market individually hand-wrapped in tissue paper and placed into bushel size boxes, with four or five layers of apple trays to a box. Once at the store, the apples are unwrapped and stacked in pyramid piles on the display stand. The procedure involves much time and leaves grocers a considerable amount of paper to dispose of.

Neatly arranging apples in the same trays, beneath a see-through plastic film makes a more attractive display. In comparison tests, about twice as many apples in trays sell as those displayed in the customary bulk display style. Reducing the waste of unsold apples also reduces costs. Costs are cut further in that the time involved in unwrapped apples and setting up displays is halved.

This new display method also reduces fruit damage. Customers can readily inspect displayed fruit without having to handle it. In a typical pyramid-style display, shoppers often pick through the apples in search of the best quality. The handling bruises the fruit and renders it less attractive for the next shopper, consequently it is less likely to be sold.

ARS agricultural economists James B. Fountain and Roy Hovey, Yakima, Wash., evaluated this new display method. They say it can be used for other fruits, such as pears, that are similarly displayed. The next step is to unitize the display trays in large bin boxes so that fruit can be delivered directly from the grower/packer to the display shelf, lowering packaging materials and transport costs even more.

Golden Delicious apples rank second in total apple production in the country, accounting for 15 percent of all production. Red Delicious apples rank first at 33 percent.

## Nitrogen on rangelands

A HIGH rate of nitrogen applied on rangelands every few years substantially increases yields, improves nutritive value of forage, and costs less than annual, smaller applications. However, ARS scientists say several undesirable side-effects make its adaptation questionable.

A mixed-grass rangeland south of Cheyenne, Wyo., produced 50 to 100 percent more forage annually and more than tripled protein yield when massive amounts of nitrogen were applied.

Single applications of up to 600 pounds of nitrogen increased the desirable western wheatgrass and decreased the undesirable fringed sagewort. The treatment, however, reduced the desirable blue grama and needleandthread grasses. During the 4-year test period, the poisonous larkspur, slimleaf goosefoot, and prairie pepperweed also increased with fertilization. The latter two species can cause nitrate poisoning when fertilized. These undesirable plants can be controlled with herbicides.

The substantial increases in yield might be expected as long as the increase in western wheatgrass continues—as long as 6 to 10 years after the nitrogen application.

ARS range scientists W. R. Houston and D. N. Hyder, Fort Collins, Colo., conducted the research.

When reporting research involving pesticides, this magazine does not imply that pesticide uses discussed have been registered. Registration is necessary before recommendation. Pesticides can be injurious to humans, domestic animals, desirable plants, and fish or other wildlife—if not handled or applied properly. Use all pesticides selectively and carefully.




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